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Sørensen, Bent F.; Goutianos, Stergios

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## **FATIGUE LIFE LIMIT PREDICTION OF UNIDIRECTIONAL COMPOSITES BASED ON MICROMECHANICS**

**B. F. Sørensen**<sup>\*</sup>, S. Goutianos

Section of Composites and Materials Mechanics, Department of Wind Energy  
Technical University of Denmark, DK-4000 Roskilde, Denmark

*\*bsqr@dtu.dk*

### **Topic:**

- Damage mechanics and damage mechanisms, property degradation;
- Models and procedures for damage evolution assessment, residual properties and life prediction;

**Keywords:** Weibull, friction, residual stress.

### **Abstract**

High performance polymer fibre composites (with long aligned fibres) are widely used in structural applications such as in wind turbine rotor blades. These structures are designed to operate for a long time e.g. over 20 years of service life for a wind turbine rotor blade. Fatigue loading and the associated material degradation are thus important parameters in the development of larger and more efficient composite structures.

The present work aims to examine if a fatigue limit exists for unidirectional fibre composite materials. The existence or not of a fatigue limit has consequences on structural design rules of composite structures and on composite materials developments.

To answer the question of existence or not of a fatigue limit, a theoretical micromechanical model is developed. The fatigue limit is defined as the condition that a fibre failure does not lead to progressive failure of neighbouring fibres. In the model, the fibre/matrix interface is described by an interface fracture energy and a frictional sliding shear stress. The fibre strength is assumed to follow a Weibull distribution. The fatigue damage is in the form of cyclic debond crack growth, decreasing frictional sliding stress and fibre failure.

The developed model is used to predict the fatigue limit of unidirectional glass fibre composites. The model predictions are compared with available high cyclic fatigue experimental data from literature and a good agreement is found.

Next the effects of the microscale parameters such as fibre volume fraction, interface fracture energy and interface frictional sliding stress on the fatigue limit are examined.